



Swiss Needle Cast on Washington State Lands, 1999-2009

January 2010

Swiss needle cast (SNC) is a native foliar disease of Douglas-fir caused by the fungus *Phaeocryptopus gaeumannii*. Swiss needle cast affects only Douglas-fir and occurs throughout its range in western Washington. The disease is common on sites with abundant spring and/or summer precipitation and where mild winter temperatures favor the growth and reproduction of the pathogen. Trees with SNC may exhibit chlorotic (yellowing) foliage, premature needle loss, thinning crowns and reduced growth. Tree mortality from SNC is rare.

IDENTIFICATION & DISEASE CYCLE

Close examination of SNC infected needles reveals rows of tiny black fruiting bodies (pseudothecia) in the stomatal openings on the underside of the needles (Figure 1). The individual fruiting bodies are black and spherical and heavy infections appear as two black streaks on the underside of the needle along each side of the mid-rib. Fruiting bodies are easily seen with a hand lens.

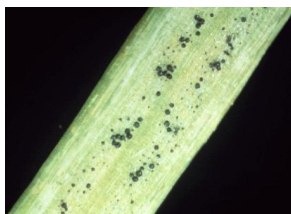


Figure 1. Black pseudothecia in the stomatal openings on the underside of a Douglas-fir needle.

The disease cycle begins in the spring when spores are released from fruiting bodies on infected needles, then are spread by wind-blown rain to newly emerging foliage. If there is adequate moisture, the fungus will germinate and penetrate new needles. The fungus then spreads through the newly

infected needle and forms fruiting bodies in the stomata throughout the fall and winter. The fungus matures and releases spores again the following spring.

GROUND SURVEYS MONITOR DISEASE SEVERITY

Washington Department of Natural Resources Forest Health staff have been conducting surveys on six sites since 1999 to monitor the incidence and severity of SNC in western Washington (Figure 2). The incidence of SNC was measured by examining the presence or absence of the fungus on Douglas-fir needles. Average incidence ranged from 0-100% across the study sites in western Washington between 1999 and 2009 (Figure 3). These results showed that *P. gaeumannii* was present on all sites surveyed, every year, except Morton in 2001.

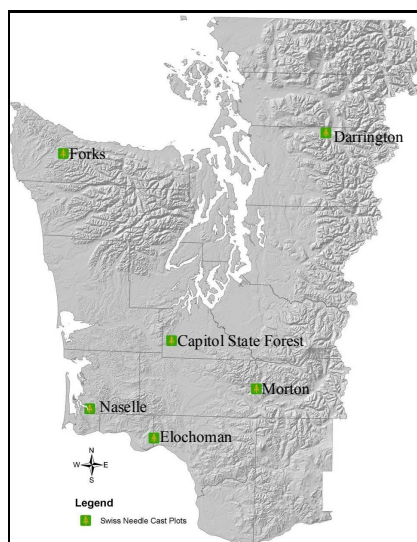


Figure 2. Swiss needle cast survey and monitoring plot locations in western Washington.

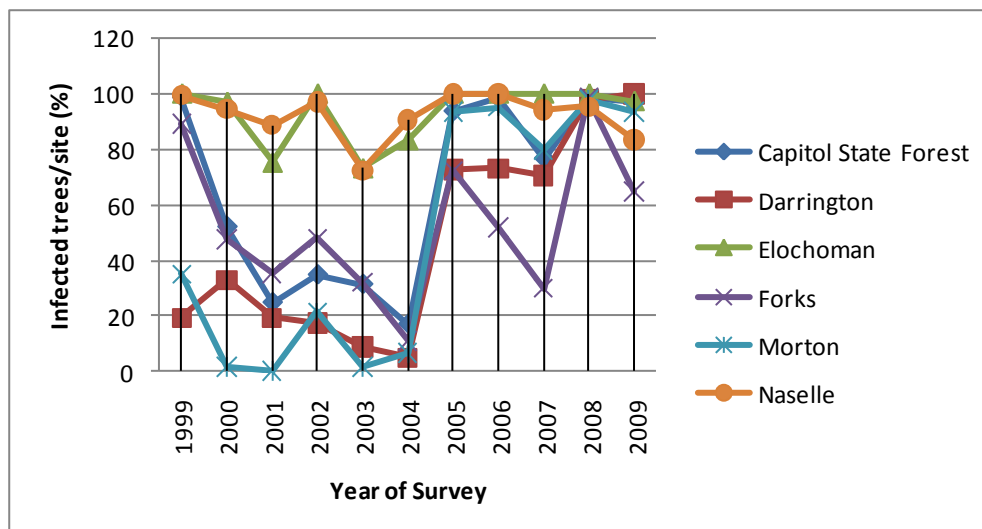


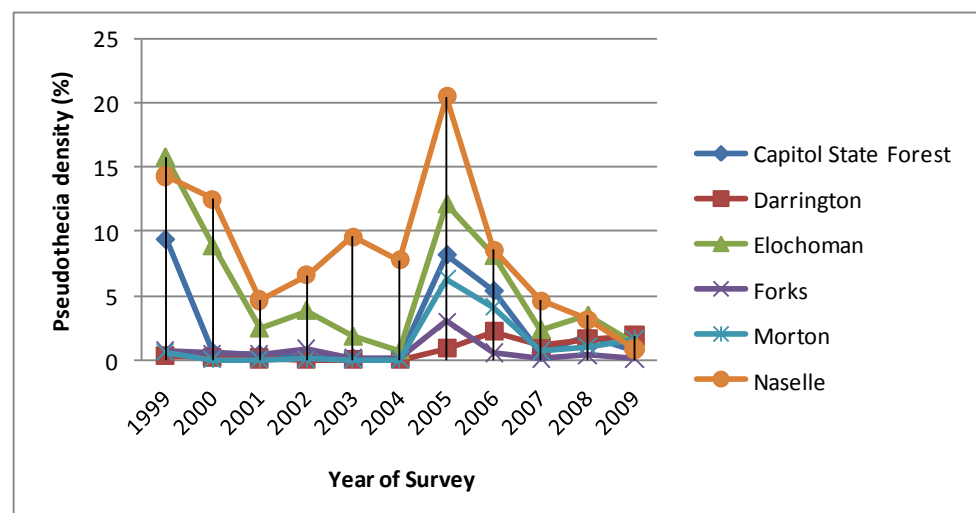
Figure 3. The incidence of SNC across six study sites in western Washington. The average percentage of trees infected with Swiss needle cast at each site, each year.

The severity of SNC was measured by counting the number of stomata occluded by fungal pseudothecia on one-year old Douglas-fir needles. Average severity ranged from 0-21% across the six study sites between 1999 and 2009 (Figure 4). The greatest percentage of stomata occluded by fungal pseudothecia in one-year old needles was at the Naselle site in 2005, at 21%. All other severity percentages were less than 16%, with 75% of the sample points (survey sites and survey years) having severity percentages below 5%.

Studies in Oregon involving SNC have shown that average respiration rates are

reduced in trees infected with SNC beginning when about 25% of the needle stomata are occluded by fungal pseudothecia (Manter et al. 2003) and that needle abscission, or needle loss, can occur when about 50% of the stomata are occupied (Hansen et al. 2000). Although many factors contribute to the exact impact of SNC, 25% stomata occluded causes moderate impacts such as respiration reduction and 50% stomata occluded causes severe impacts such as needle abscission. More work is needed to determine growth loss in forest stands in southwest Washington, where pseudothecia densities are the highest. However, if the Oregon standards are used, SNC appears to

Figure 4. The severity of SNC across six study sites in western Washington. The average number of pseudothecia on each needle per tree per site.



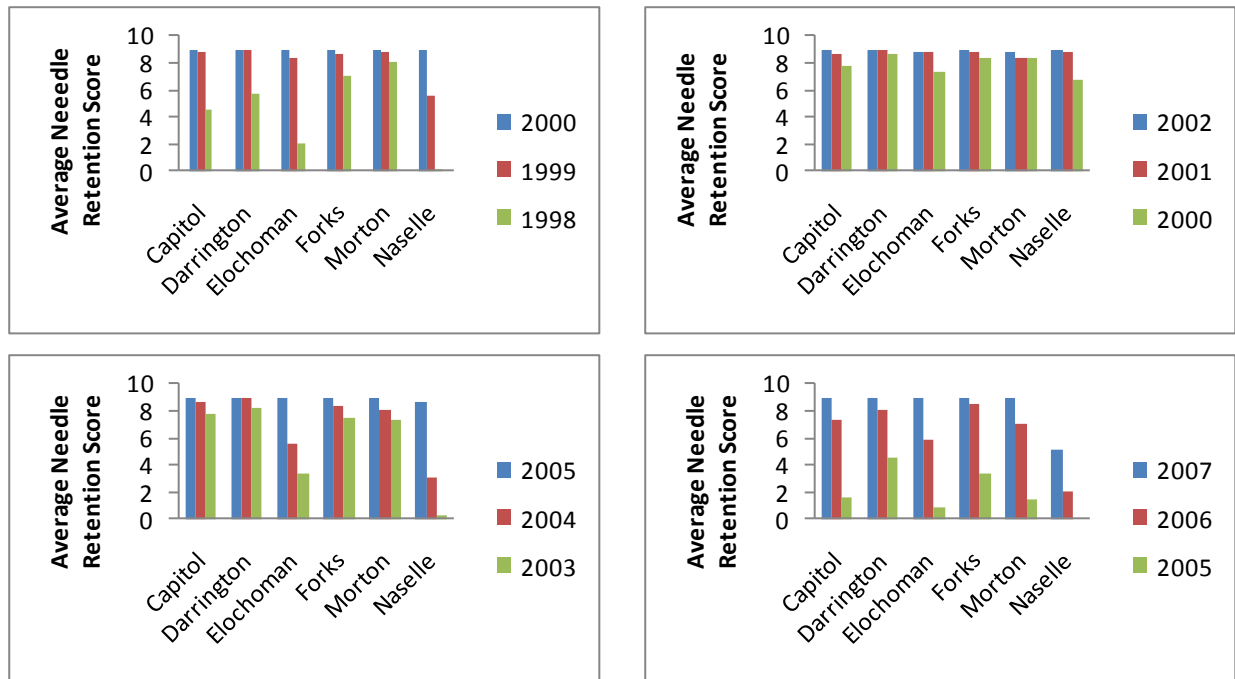


Figure 5. Average needle retention score for each study site. 1998-2000 results were collected in 2001, 2000-2002 collected in 2003, 2003-2005 collected in 2006 and 2005-2007 collected in 2008.

be having little impact on respiration or needle loss in one-year old needles in the Washington study sites.

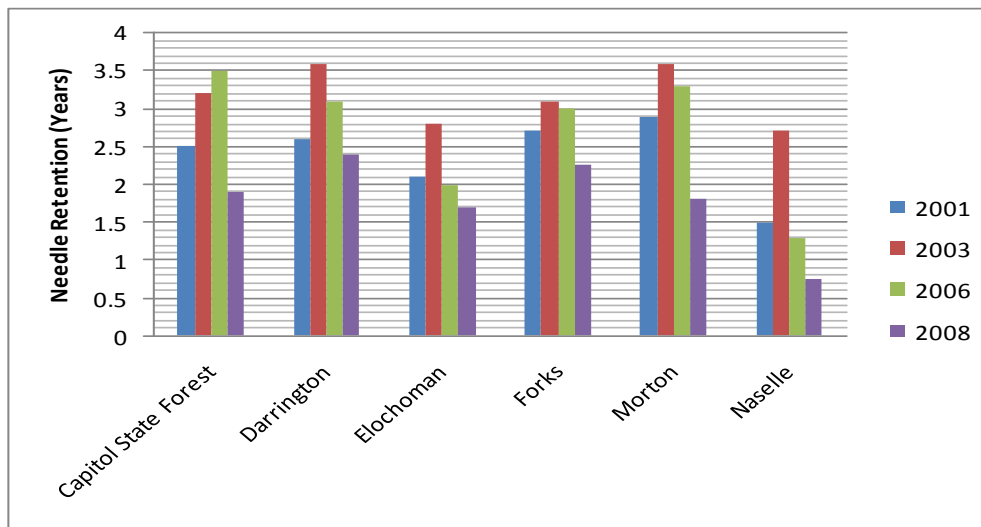
We also looked at needle retention in 2001, 2003, 2006 and 2008 as another indicator of SNC severity. Each whorl was scored based on the percentage of needles remaining on the branch cohort, with 9 representing 90-100% foliage present and 0 representing 0-10% foliage present (Figure 5). Only the results from one, two and three-year old cohorts are reported.

The needle retention scores remained relatively high (between 80 to 100% of the foliage retained in the one and two-year old needles) on most sites. However, Elochoman and Naselle trees retained less than 60% of the three-year old foliage in 1998, 2003 and 2005. Several other sites also retained less than 60% of the two and three-year old foliage.

Needle retention data were also averaged for each site and each year of observations and reported as needle retention in years (Figure 6). These results shows that average needle retention can fluctuate from year to year, likely due to yearly changes in SNC disease pressure, including the presence or absence of weather conditions favoring new infections, and the occurrence of other events or site conditions that can contribute to premature needle loss.

An additional factor likely contributing to low needle retention rates is wind. An extratropical cyclone in December, 2007, accompanied by wind gusts of up to 145 mph likely contributed to the needle loss observed in 2008 on two and three-year old needles (2006 and 2005 needles, respectively). While storms of this intensity are not common, winter storms with wind gusts above 30 mph occur at least once a year and cyclones with wind speeds greater than 60 mph tend to occur at least once every two years.

Figure 6. Average needle retention, in years, per site in western Washington. Observations were made in 2001, 2003, 2006 and 2008.



MANAGEMENT OPTIONS

Winter storm intensities, wind speeds, proximity to damaging salt spray and SNC intensity should be taken into account when assessing needle retention. Average needle retention, in years, of coastal Douglas-fir is approximately 4 years. Studies in Oregon suggest that trees probably do not have a problem, or have reduced growth, if three or more years of foliage are present (Maguire et al. 2002).

If you have a stand of Douglas-fir that you suspect may have SNC and the trees may be experiencing growth loss, you may want to consider thinning your stand to promote growth of the residual trees, fungicidal treatment on young trees, or replanting with a mix of conifer and hardwood species. In many of the areas where SNC is causing growth loss in Douglas-fir, the historical species composition was primarily Sitka spruce, western hemlock and alder.

MORE INFORMATION

For more information about this project, methods for determining needle retention, management recommendations for forest stands with SNC caused growth loss, or other forest health projects, please contact:

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The Swiss Needle Cast Cooperative also has some great information on their website, <http://www.cof.orst.edu/coops/sncc/>.

Hansen, E.M., Stone, J.K., Capitano, B.R., Rosso, P., Sutton W., Winton L., Kanaskie A., and M.G. McWilliams. 2000. Incidence and impact of Swiss needle cast in forest plantations of Douglas-fir in coastal Oregon. *Plant Disease*. 84: 773-779.

Manter, D.K., Bond, B.J., Kavanagh, K.L., Stone, J.K., and G.M. Filip. 2003. Modelling the impacts of the foliar pathogen, *Phaeocryptopus gaeumannii*, on Douglas-fir physiology: net canopy carbon assimilation, needle abscission and growth. *Ecological Modeling*. 164: 211-226.